NOTES ON THE SCORPION FAUNA OF THE CAPE

PART 4

THE BURROWING ACTIVITIES OF SOME SCORPIONIDS AND BUTHIDS (ARACHNIDA, SCORPIONIDA)

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(With 1 figure and 2 tables)

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ABSTRACT

Burrowing activities of the scorpionid *Opisthophthalmus macer* Thorell were studied in the field and laboratory, and comparisons made with *O. capensis* (Herbst). *O. karrooensis* Purcell, *O. pallidipes* Koch and *O. peringueyi* Purcell were found to burrow only in their immature stages. The morphological adaptions of the adults are discussed in relation to their scrape-dwelling habit. The specialized digging behaviour of the buthid *Parabuthus planicauda* (Pocock) is described. Pregnant females were often found to construct proper burrows prior to parturition.

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INTRODUCTION

Opisthophthalmus macer Thorell is a true burrowing scorpionid, distributed from False Bay to Port Elizabeth along the south coast. In this paper the burrow morphology and burrowing behaviour of this scorpion are reported and compared to the corresponding activities of *O. capensis* (Herbst).

O. karrooensis Purcell, *O. pallidipes* Koch and *O. peringueyi* Purcell all occupy the drier semi-desert regions of the Cape, namely the Karoo and Namaqualand southwards to Piketberg. The young of these species are true burrowers, whereas the adults have in common a scrape-dwelling habit with special morphological adaptions for this particular way of life.

Digging behaviour has been reported in the Buthidae and shows certain similarities to *Parabuthus planicauda* (Pocock) and *P. capensis* (Ehrenberg). This was illustrated by Pavlovsky (1924) for the transcaspian species *Liobuthus kessleri* Birula, where the first three pairs of walking legs were used for excavation. Lankester (1882) reported on the digging behaviour of the Egyptian species *Buthus australis citrina* (Hemprich & Ehrenberg). In this case the

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pedipalps aided the first three pairs of legs in digging operations.

P. planicauda is a widely distributed buthid of the southern Cape, extending from Worcester and Tulbagh in the west to Albany and Cathcart in the east (Lawrence 1955). Under certain conditions this species may construct true burrows. The specialized digging behaviour of this species is discussed in relation to the activities of *P. capensis* (Ehrenberg).

DISCUSSION

Opisthophthalmus macer Thorell

Two demes of this species were studied. The first was found on the southern slopes of the Kleinriviersberge in a habitat consisting of macchia, namely Proteaceae, Restionaceae, Ericaceae, Geraniaceae and other families. Available ground cover was sandstone and quartzite debris and the substratum was deep, sandy loam rich in organic matter.

O. macer was found to burrow only beneath suitable ground cover. Typically a run was constructed with a single entrance, leading to the burrow opening. Often an antechamber was present, the probable function of this being a feeding area. The burrows of females were invariably longer than those of males and often males were found to construct only a run. Table 1 gives the measurements of twenty burrows and runs.

The second deme was located next to the sea in the southern part of Walker Bay. This habitat consisted of rocky limestone slopes with very little soil and low coastal scrub. In this habitat the burrows were generally shorter and none were found with an antechamber in the run. Specimens were also more darkly coloured. Table 1 gives the measurements of ten burrows and runs of the second deme.

Burrowing behaviour of *O. macer* was observed as follows: compacted soil was loosened by the action of the chelicerae and scraped into a heap by the first two pairs of walking legs. The heap was then moved backward by legs I and II, which were tucked beneath the body. Legs III and IV provided the traction while the tail was extended, the pedipalps being used as supports.

The tarsal claws of *O. macer* are more sharply curved than those of *O. capensis*. According to Newlands (1972) this is related to a pelophilous habit. This view could not be substantiated in the present study, since the Kleinriviersberge deme was located in sandy loam and the deme from the coastal habitat was found to burrow in compacted sand, whereas *O. capensis* from the Cape Peninsula burrowed in sandy loam only. Tail scraping was not observed although the heavily sclerotized fifth caudal segment of *O. macer* is adapted for this function.

The scrape-dwellers, *Opisthophthalmus karrooensis* Purcell, *O. pallidipes* Koch and *O. peringueyi* Purcell

Observations of a deme of *O. karrooensis* showed that although the adults were found to occupy scrapes or runs, or simply depressions beneath stones,

TABLE 1

Measurements in centimetres of twenty burrows and runs of *Opisthophthalmus macer* in a habitat of Cape macchia (Deme 1), and ten burrows in a limestone and coastal scrub habitat (Deme 2).

		Deme 1			Deme 2		
		Min.	Max.	Mean	Min.	Max.	Mean
Run length	♂	8,0	19,0	16,5	6,0	10,0	7,0
	♀	3,0	14,0	10,2	2,5	7,0	5,0
Run width	♂	2,5	3,2	3,0	2,2	3,0	2,6
	♀	2,5	3,0	2,6	2,2	2,8	2,6
Burrow entrance height	♂	2,5	3,2	3,0			
	♀	3,0	3,5	3,2			
Burrow entrance width	♂	2,0	3,0	2,8	2,0	3,0	2,6
	♀	1,8	2,8	2,6	1,4	2,6	2,1
Burrow length	♂	0,0	12,0	6,0	0,0	6,0	4,5
	♀	12,0	18,0	14,0	4,0	8,0	6,0
Vertical depth of burrow	♂	3,0	8,0	5,0	3,0	6,0	4,0
	♀	4,0	11,0	7,0	3,0	10,0	4,5

the immature stages constructed burrows characteristic of other groups in this genus. These burrows opened beneath ground cover and the length and breadth varied with the stage of development. The burrows were often simple, straight tunnels varying from 2 to 9 cm in second and third instars to 6 to 17 cm in subadults.

The scrape-dwelling habit of adults and burrowing by the young was also evident in populations of *O. pallidipes* and *O. peringueyi* from the Clanwilliam district. Table 2 shows the relationship between the mode of shelter and certain morphological characters for ten species of *Opisthophthalmus*.

The pedipalps of these three species are powerful and heavily sclerotized. The chelae of the males in particular are very long and afford frontal and lateral shielding of the opisthosoma (Fig. 1). The mesosoma is broad and distinctly dorsoventrally compressed, and the metasoma slightly more laterally compressed than those species which burrow in all stages. The tail is adapted for tail-scraping operations by being heavily sclerotized.

Parabuthus planicauda (Pocock)

While collecting this species in a variety of habitats over a very large area it was noticed that pregnant females were usually found in deep, narrow

TABLE 2

Species of *Opisthophthalmus* indicating the relationship between certain morphological characters and mode of shelter.

Species	Prosoma and Mesosoma	Metasoma	Chela	Shelter
O. capensis (Herbst)	not strongly dorsoventrally compressed	not laterally compressed	not elongated in ♂	adults and young burrow
O. gigas Purcell	strongly dorsoventrally compressed	slightly laterally compressed	elongated in ♂	adults scrape-dwellers no data for young
O. granifrons Pocock	not strongly dorsoventrally compressed	not laterally compressed	not elongated in ♂	adults and young burrow
O. karrooensis Purcell	strongly dorsoventrally compressed	slightly laterally compressed	elongated in ♂	adults scrape-dwellers young burrow
O. latimanus Koch	not strongly dorsoventrally compressed	not laterally compressed	not elongated in ♂	adults and young burrow
O. longicauda Purcell	strongly dorsoventrally compressed	slightly laterally compressed	elongated in ♂	no data
O. macer Thorell	not strongly dorsoventrally compressed	not laterally compressed	not elongated in ♂	adults and young burrow
O. pallidipes Koch	strongly dorsoventrally compressed	slightly laterally compressed	elongated in ♂	adults scrape-dwellers young burrow
O. peringueyi Purcell	strongly dorsoventrally compressed	slightly laterally compressed	elongated in ♂	adults scrape-dwellers young burrow
O. wahlbergi (Thorell)	not strongly dorsoventrally compressed	not laterally compressed	not elongated in ♂	adults and young burrow

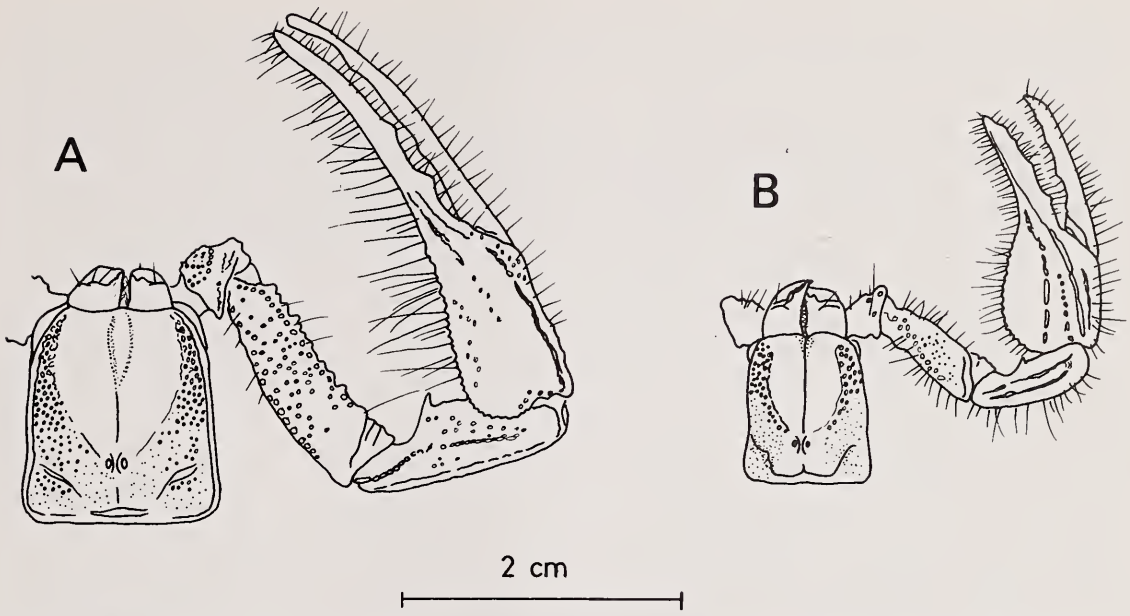

Fig. 1. Pedipalp and prosoma of male specimens of A. *Opisthophthalmus karrooensis* and B. *O. macer*.

depressions or properly constructed burrows, opening beneath stones. The entrances were oval or round and the burrows varied from 4 to 11 cm in length. Males, non-pregnant females, and young were found in scrapes of varying shapes and lengths. Often specimens occupied natural depressions under stones, where there was no evidence of excavation.

Laboratory specimens of pregnant females were observed scraping sand as follows: the tail was curved either sideways or directly over the mesosoma so that the telson lay above the carapace, and the first two pairs of walking legs were used in alternative scraping motions to loosen the sand. The body was then raised by stilting on the hind legs while the first two pairs of legs and sometimes the third pair scraped the sand very vigorously so that it sprayed out behind the scorpion; the pedipalps and fourth pair of legs were used as supports during this operation. Transport of soil from a burrow was not observed.

The defensive armature of *Parabuthus* consists of the well-developed metasoma and highly toxic venom. It was observed that the terminal chambers of the burrows were wide enough to enable the sting to be used effectively, and the deep narrow depressions were constructed so as to allow the sting to be employed without hindrance.

CONCLUSIONS

When the burrowing behaviour of *O. macer* was compared to *O. capensis* only one difference was noted, namely the scraping of soil into a heap by the first two pairs of legs prior to removal from the burrow in the former species. Eastwood (1978) noted that *O. capensis* modified its behaviour under different

substratum conditions. For example, when the soil was dry the scorpion transported it backwards out of the burrow in a single rapid movement, whereas if it was damp or there were stones or other obstacles in the soil, it was removed in a series of backward jerks. Thus it appears that the pattern of behaviour is flexible to accommodate various ecological conditions. It may be that the scraping of soil into a heap prior to transportation is used by *O. capensis*, but was not observed in this species because the conditions of the soil did not require it. However, this observation illustrates that more detailed information is required to determine significant specific behaviour patterns. The measurements of burrows and runs for the demes occupying two different habitats indicate that burrow and run length are a function of the nature of the habitat, i.e. the Kleinriviersberge specimens had deeper burrows since the substratum consisted of deep, sandy loam, whereas in the coastal habitat of the second deme, specimens constructed shallower burrows in pockets of compacted sand on a limestone outcrop. Generally *O. macer* and *O. capensis* show similar trends in burrow construction and behaviour, and more in-depth studies would be necessary to determine significant differences.

The scrape-dwelling species of *Opisthophthalmus* are adapted to their habitat by the development of a flattening of the body and the increased effectiveness of defensive and aggressive armature. That the young of these forms are burrowers indicates that they may have evolved from the true-burrowers. The flattening of the opisthosoma and metasoma and elongation of the chelae are also characteristic of the ischnurinine genus *Hadogenes*, a lithophilous form, and is a good example of parallel evolution.

The burrowing habit of *P. planicauda* appears to occur only in females prior to parturition. The sand-scraping behaviour of this species is essentially the same as that reported for *P. capensis* by Eastwood (1977). Removal of soil in large quantities by *P. capensis* was not observed in *P. planicauda*. However, this process is obviously necessary for burrow excavation, since the confined space at the entrance would not allow for the posture required for sand-scraping operations. No doubt many other *Parabuthus* species will be found to burrow and a great deal needs to be studied with respect to functional morphology, burrowing behaviour and the relationship to the type of habitat.

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